DHS S&T Bioterrorism Risk Assessment (BTRA)

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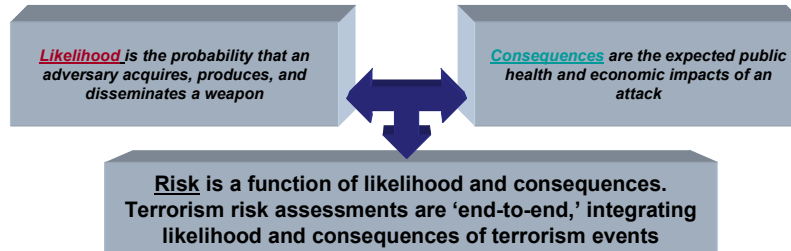DEPARTMENT OF HOMELAND SECURITY

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Overview

- Risk assessment
- Risk scope and parameters
- Methodology
- Integrated CBRN risk assessment
- Summary

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DHS is Committed to Risk Informed Decision Making

[Risk] = [Likelihood] * [Consequences]

Likelihood is the probability that an adversary acquires, produces, and disseminates a weapon

Consequences are the expected public health and economic impacts of an attack

Risk is a function of likelihood and consequences. Terrorism risk assessments are 'end-to-end,' integrating likelihood and consequences of terrorism events

…assure DHS provides risk-analysis information to a full range of decision-makers, and assure that the Department's strategies are risk-based."

- DHS Secretary Janet Napolitano 02/25/09

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DHS Bioterrorism Risk Assessment Goals

- Create a flexible risk assessment tool that can be used to inform Policy Makers
    - Perform an end-to-end assessment of risk associated with bioterrorism to inform biodefense investment decisions
    - Identify and prioritize key knowledge and vulnerability gaps
    - Utilize tool to evaluate risk mitigation options
- Required by Homeland Security Presidential Directive 10 (2004), *Biodefense for the 21st Century*, BTRA is a first of its kind assessment and DHS is committed to a process of continual review, investment, and improvements to the BTRA.
- Continual improvement of the tool as necessary to enhance the risk assessment process and address stakeholder requests
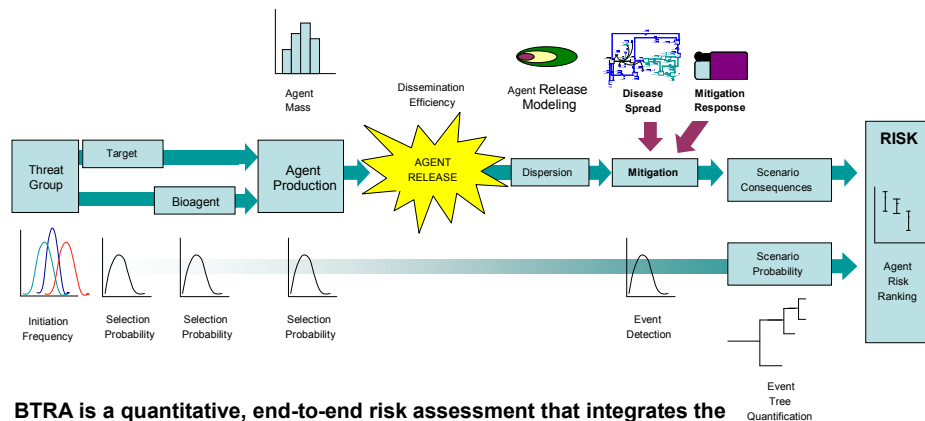
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BTRA is in its Third Iteration

- BTRA Reports
  - First BTRA issued in 2006 using a Probabilistic Risk Assessment (PRA) approach to address bioterrorism risk for 28 biological agents
  - Second BTRA issued in 2008 using same approach and covered 37 agents
    - Enhanced to include economic consequences, agriculture threats, intelligence community probability estimates, enhanced consequence models and consequence uncertainty
  - Third BTRA is in preparation for delivery in 2010 and covers 38 agents, updated IC probability estimates, updated input data, enhanced PHR model, includes multiple studies using the BTRA tool to address specific risk related questions.

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Scope of the BTRA is End-to-end

BTRA is a quantitative, end-to-end risk assessment that integrates the findings of the intelligence and law enforcement communities with input from the scientific, medical, and public health communities.
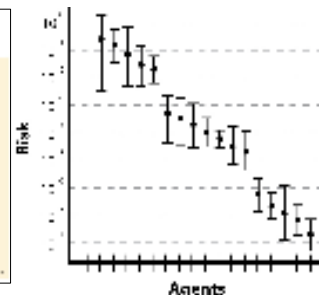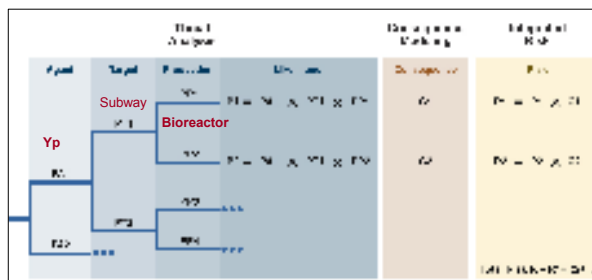
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BTRA uses a Probabilistic Risk Analysis (PRA) Methodology

- Risk is a function of likelihoods and consequences.
    - Consistent method for aggregating risk from a large set of scenarios with consideration of uncertainty
    - Useful for comparing risks against one another in a manner that captures uncertainty
    - Allows for multiple visualizations and outputs.
    - Provides decision-makers with the opportunity to ask the 'what-if' questions. Can estimate the impacts of potential risk mitigation strategies.
- PRA has been applied to engineered systems, aerospace, and the chemical industry

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PRA Uses an Event-Tree Format – Binary Example

- **Ability to adjust parameters to address different questions**
- **Ability to query system at consequence level of interest**

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4

BTRA Tree is Larger than the Example

- The event tree used in the BTRA has 21 events
- Each event has multiple branches, rather than two
    - The tree is much too big to be drawn
- Each branch split fraction is represented by a distribution, rather than a single value
    - These distributions represent uncertainty in knowledge of terrorist capabilities and their likely actions
- In most cases, events further down the tree (higher-numbered events) depend on one or more of the events that come before it (lower-numbered events)
- Each pathway through the event tree is referred to as a "scenario", there are a total of 225,000 non-zero risk scenarios consisting of a total of 900,000 branches
- Each scenario is run 500 times to generate a distribution of risk results

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2010 BTRA Event Tree Has Many Dependencies

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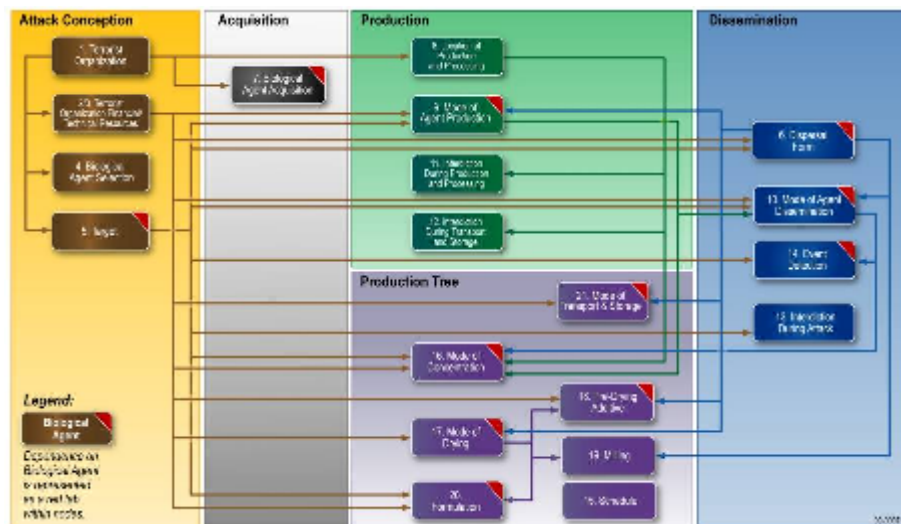
BTRA Events

42 potential bioterrorism agents (**37** human, **5** livestock pathogens) that can be obtained from

2 locations (foreign and domestic) by

5 routes of acquisition with

6 methods of production and weaponization, attacking

20 different targets (subway, stadium, transportation, outdoor events, etc.) using

8 modes of dissemination (food, aerosol, etc.) by

4 terrorist organization types causing exposure via

2 routes; inhalation and ingestion leading to

3 public health consequences; illnesses, fatalities and economic cost
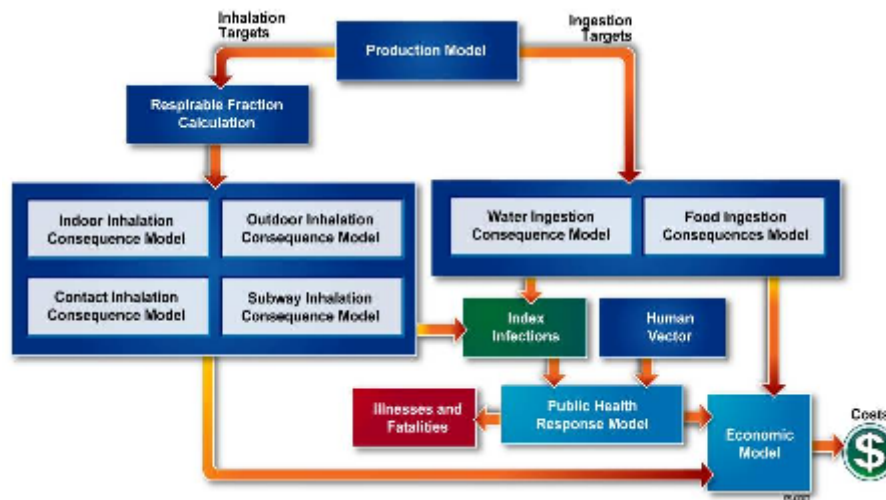
= Millions of enumerated scenarios

Threat Analysis Inputs to the BTRA Process
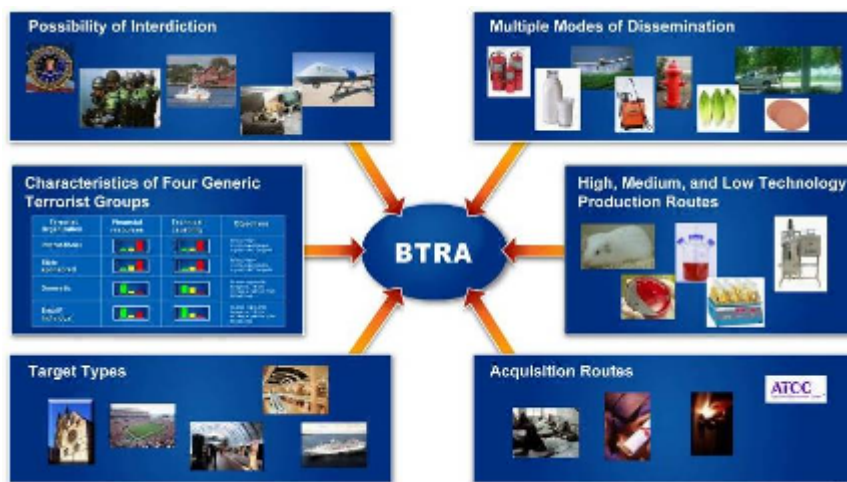
Consequence Models

Public Health Response Model

PHR model is a medical mitigation model and account for the effectiveness of PHR measures on health outcomes.

Public Health Response effectiveness is determined by

- Time delay between exposure and initiation of treatment
  - Event detection/Clinical diagnosis
  - Transfer and distribution of treatment measures
- Effectiveness of countermeasures
- Quantity of countermeasures
- Disease-specific mortality rates for treated and untreated cases.

Unlike agent parameters (such as untreated mortality rates), event identification timelines may be impacted by human actions

38 Human Health Agents Considered

- Abrin
- Alpha Amanitin
- *Bacillus anthracis*
- Bovine spongiform Encephalopathy (BSE)
- *Brucella suis*
- *Burkholderia mallei*
- *Burkholderia pseudomallei*
- *Chlamydia psittaci*
- Clostridium botulinum toxin
- Clostridium perfringens epsilon toxin
- Crimean Congo HF virus
- *Coxiella burnetii*
- *Cryptosporidium parvum*

- Eastern equine encephalitis virus
- Ebola virus
- *Escherichia coli O157:H7*
- *Francisella tularensis*
- Herpes B virus
- Junin virus
- Lassa Fever virus
- Marburg virus
- Monkeypox virus
- Multidrug Resistant (MDR) *Bacillus anthracis*
- Multidrug Resistant (MDR) TB / Extremely drug Resistant (XDR) TB
- Nipah virus

- Norovirus
- Rabies
- Ricin
- *Rickettsia prowazekii*
- Rift Valley Fever virus
- SARS
- *Salmonella typhi*
- Saxitoxin
- Shigella toxin
- Staphylococcal enterotoxin B
- Variola major
- *Vibrio cholerae*
- VEE
- *Yersinia pestis*

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Example Data Presentations

- Results are displayed as a relative risk ranking which can be generated based upon multiple metrics including:
  - Fatality risk
  - Illness risk
  - Economic risk
  - Probability vs. Consequences
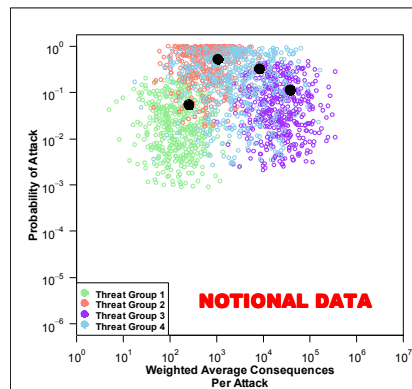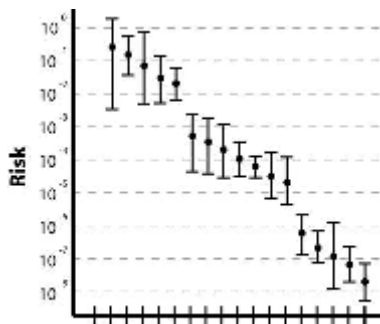
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Sensitivity Studies and Risk Reduction Studies are Performed

Understanding potential impacts of overarching decisions and identifying risk-informed operational goals
- *"What can be done to reduce the overall risk?"*

Understanding the impact of estimates and uncertainties
- *"What if the current estimates are too high/low?"*

- Approaches to performing sensitivity studies:
  - Alter input parameters and re-run risk model
  - Process risk results differently
  - Change calculation approach
- Sensitivity studies use one, two, or all three of these methods to obtain desired sensitivity comparisons

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Program Impact
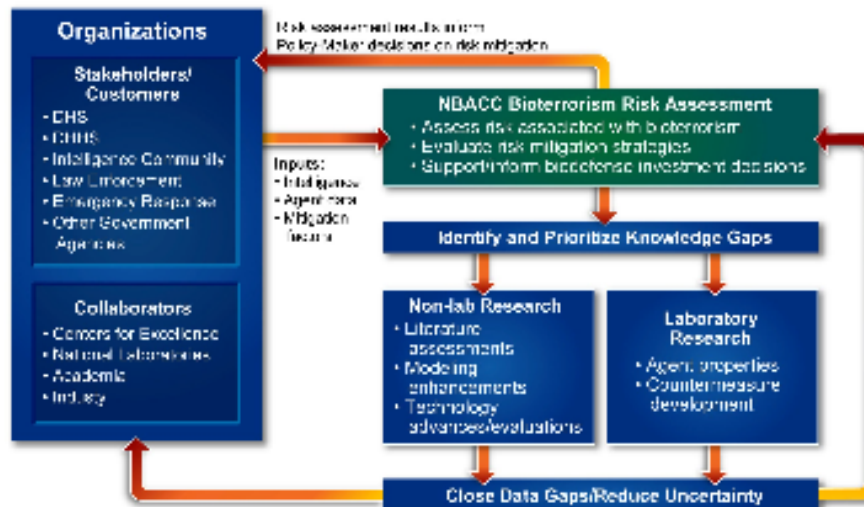
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Intra/Interagency Coordination

DHS:
- DHS OHA
- DHS OI&A
- DHS Policy
- National Laboratories

Interagency:
- DoD
- Intelligence Community
- USDA

- HHS/ASPR
- HHS/FDA
- HHS/CDC
- HHS/NIH
- HHS/AHRQ
- EPA
- DOJ/FBI

Academia:
- University of Southern California
- University of Minnesota
- University of Maryland

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Integrated Terrorism Risk Assessment (ITRA) for National Homeland Security Strategy
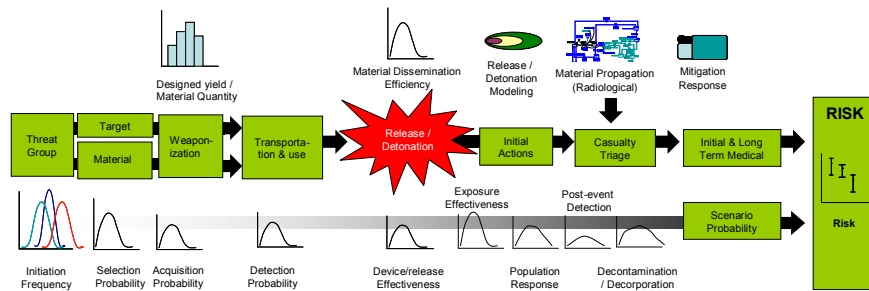

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Required by HSPD-18: *Medical Countermeasures against Weapons of Mass Destruction*

§ 14 (c) *"The Secretary of Homeland Security shall develop a strategic, integrated all-CBRN risk assessment… the Secretary of Homeland Security shall submit a report to the President…which shall summarize key findings…and shall update those findings when appropriate, but not less frequently that every 2 years."*

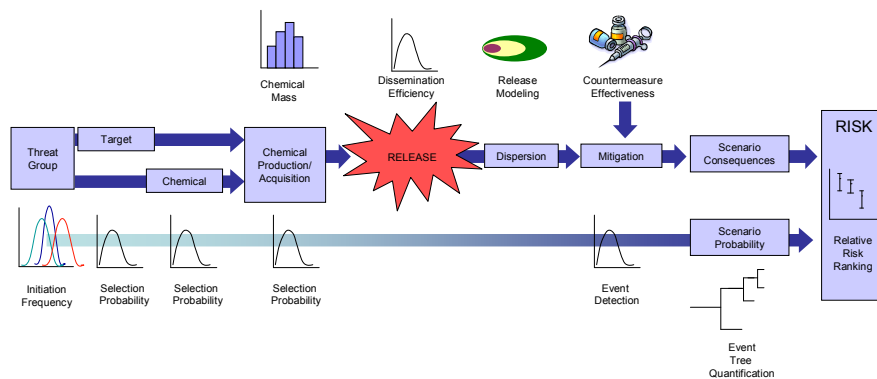**Homeland Security**

# ITRA Uses a Common Modeling Framework

Chemical Terrorism Risk Assessment (CTRA)

Chemical Terrorism Decision Process

- 57 chemicals that can be obtained from
- 2 locations; foreign and domestic using
- 4 methods of acquisition; production, theft,
- purchase, or chemical supply chain, to by used against
- 10 target classes consisting of
- 26 different targets by
- 13 modes of dissemination techniques by
- 4 terrorist organization types causing exposure via
- 3 routes; inhalation, ingestion, and dermal leading to
- 2 public health consequences; injuries and fatalities

# Radiological/Nuclear Risk Assessment (RTRA, NTRA)
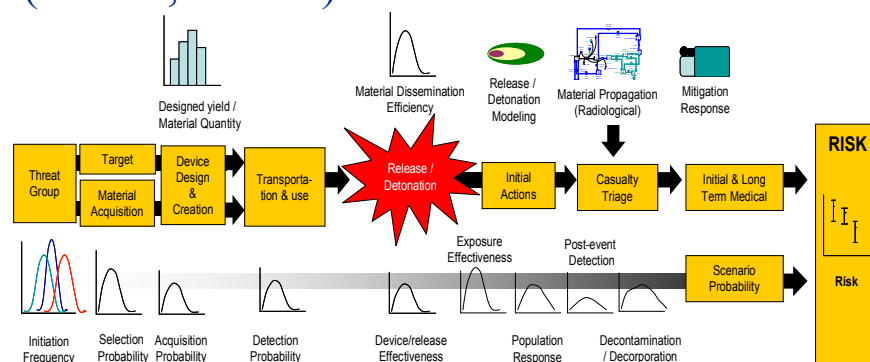
Radiological Terrorism Decision Process

- 11 radionuclides that can be obtained from
- 3 locations; CONUS, Canada/Mexico, Outside North America in
- 3 radionuclide specific sizes via
- 4 methods of entry into the U.S. attacking
- 16 different targets by
- 4 concepts of operations using
- 9 modes of dissemination and exposure from
- 4 terrorist groups causing exposure via
- 3 routes; inhalation, ingestion, exposure leading to
- 3 public health consequences; acute radiation sickness, early fatality, latent cancer fatality
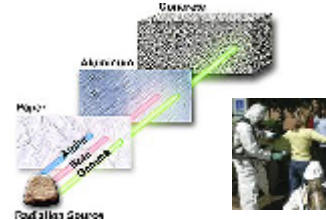
Nuclear Terrorism Decision Process

- 4 types of special nuclear material that can be obtained from
- 3 locations; CONUS, Canada/Mexico, Outside North America in
- 16 different combinations of yield and size using
- 4 concepts of operation via
- 4 methods of entry into the U.S. attacking
- 3 different city types caused by
- 2 terrorist groups leading to
- 3 public health consequences;
     acute radiation sickness,
   early fatality,
     latent cancer fatality

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13
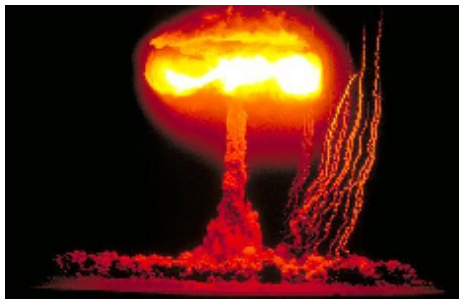
Common Consequence Models are Used When Possible

- Objective of consequence models is to provide estimates of **illnesses/injury**, **fatalities** and **economic impact** for a broad range of scenarios
  - Generic target models
    - Indoor targets, Outdoor targets, Ingestion Pathways
  - Consequence uncertainty is carried through the analysis
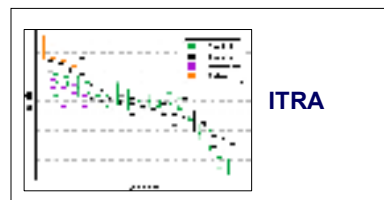 - Consistent set of assumptions to ensure comparability between threats.

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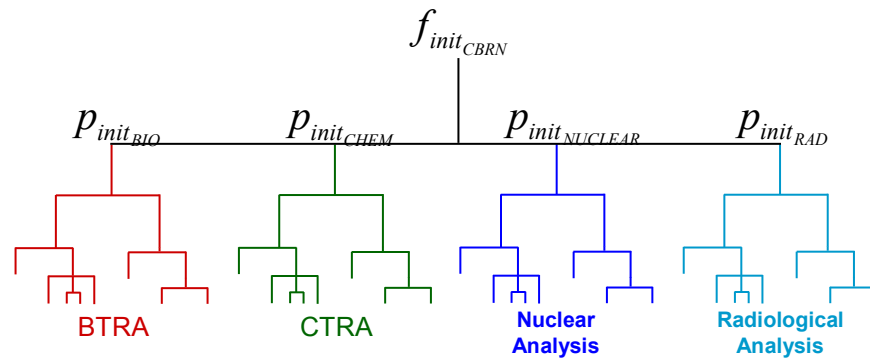# Risk Frameworks are Integrated to Cross Compare Nodes
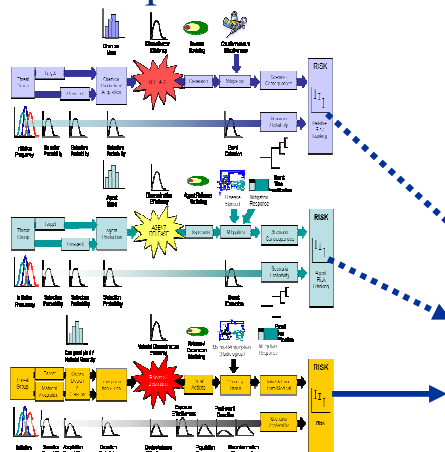
Quantitative, end-to-end risk assessments that integrate the findings of the intelligence and law enforcement communities with input from the scientific, medical, and public health communities.
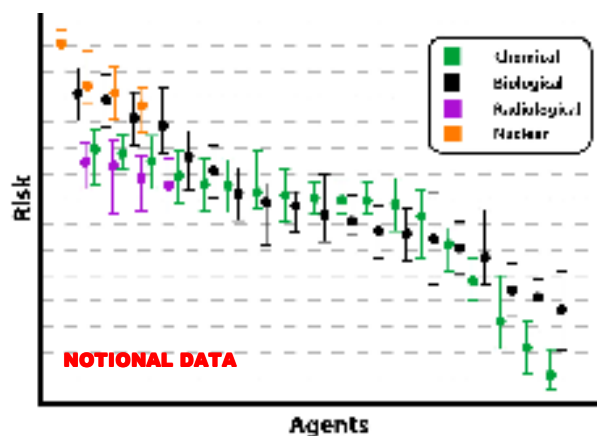
ITRA

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How are the C, B, R, and N components integrated together?

- Integration uses:
  - a new, targeted elicitation of *relative probabilities that an initiation will be C, B, R, or N* from a single panel of CBRN terrorism intelligence analysts
  - An elicitation of absolute CBRN frequency of initiation
  - Harmonization of apples to apples modeling components and inputs

$$f_{init_{CBRN}}$$

$$p_{init_{BIO}} \qquad p_{init_{CHEM}} \qquad p_{init_{NUCLEAR}} \qquad p_{init_{RAD}}$$

BTRA   CTRA   **Nuclear Analysis**   **Radiological Analysis**

Step 1: Risk Assessment
Direct Comparisons Across WMD Threat Areas

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15

Risk Assessment continued
Probability Versus Consequences
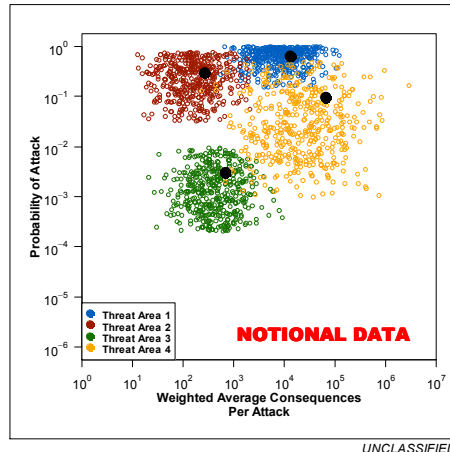
Step 2: Risk Management
Decision Support and Sensitivity Studies

- Stakeholder driven tailored assessments
  - Faster response times
  - Detector systems
  - Risk driver identification and investigation

- Knowledge gap analysis
- Attack size estimates for planning scenario development
- IC collection requirements
- And more…

TRA Program Accomplishments

- **Used to support investments and resource prioritization:**
  - Homeland Security Council priorities
  - Project BioShield Support
  - EPA Persistence Working Group
  - Integrated Consortium of Laboratory Networks
  - BioWatch Support
  - Priorities for CBRN security
  - Knowledge Gaps and Risk Drivers
  - Intelligence Collection Requirements

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Intra/Interagency Coordination

DHS:
- DHS OHA
- DHS OI&A
- DHS CPB
- DHS FEMA
- DHS Policy
- DHS OIP
- DHS DNDO
- National Laboratories

Interagency:
- DoD
- Intelligence Community
- USDA
- DOE
- NRC

- HHS/ASPR
- HHS/FDA
- HHS/CDC
- HHS/NIH
- HHS/AHRQ
- EPA
- DOJ/FBI
- EOP/OSTP

Academia:
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ITRA Summary

- First delivered in Fall 2008, the 2011 integrated CBRN risk assessment will provide a next generation ***end-to-end quantitative risk assessment*** across all WMD threats

- **As with BTRA and CTRA, new iteration provides additional value to stakeholders**
  - Modeling improvements and enhancements
  - Incorporation of new information
  - Inclusion of economic impacts
  - Broader focus on stakeholder-led risk management and sensitivity studies
  - Interagency coordination and socialization

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